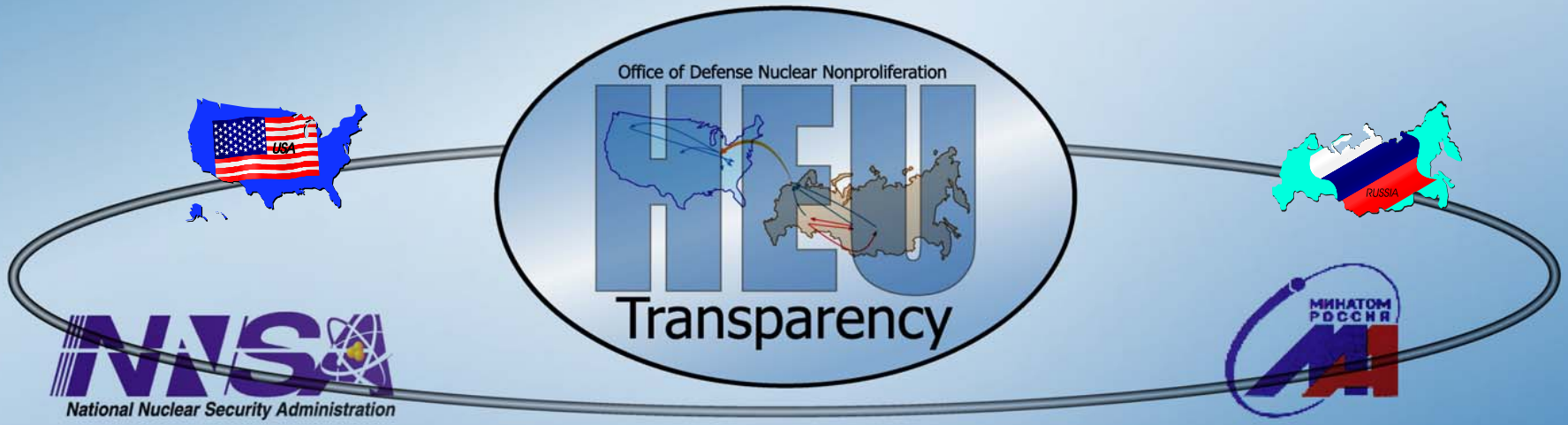
Highly Enriched Uranium Transparency Implementation Program

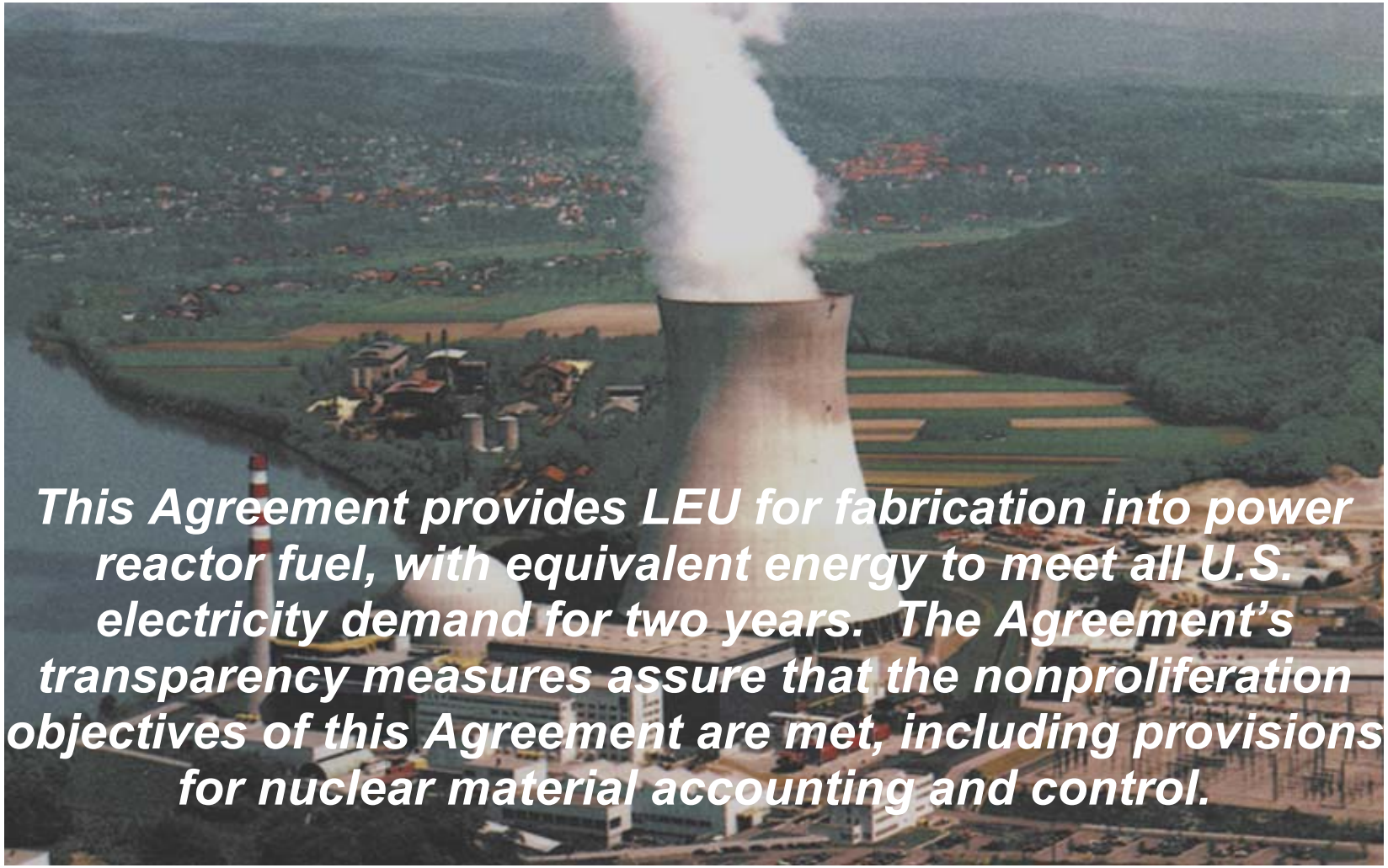


Office of International Nuclear Safety & Cooperation

The United States-Russian Intergovernmental HEU-LEU Agreement

"Megatons" are being converted to……

The United States-Russian Intergovernmental HEU-LEU Agreement



…….“Megawatts” under the U.S.-Russian Intergovernmental HEU-LEU Agreement

Evolution of the HEU-LEU Agreement

August 31, 1992: President Bush (pictured with President Yeltsin) announced that the United States and the Russian Federation have negotiated and initialed the HEU Purchase Agreement

March 18, 1994: Vice-President Gore and Russian Prime Minister Chernomyrdin sign Protocol on HEU Transparency Arrangements in Washington, D.C.

June 30, 1995: Energy Secretary O'Leary and Russian Minister Mikhailov sign Joint Statement on Transparency Arrangements in Moscow

Transparency Overview

- Transparency is those agreed upon measures used to build confidence that the arms control and nonproliferation objectives of the 1993 United States - Russian Highly Enriched Uranium (HEU) Agreement are being met.

- The goal of the HEU Transparency Implementation Program (TIP) is to support the implementation of United States (U.S.) nonproliferation policy by providing confidence that Russian low enriched uranium (LEU) sold to the United States is derived from HEU removed from dismantled Russian nuclear weapons.

- The Program benefits United States nonproliferation policy by assuring the permanent removal of 500 metric tons of weapons-grade HEU in Russia, equivalent to about 20,000 nuclear weapons.

Transparency Under the Intergovernmental HEU-LEU Agreement

- **Transparency measures are to assure that:**

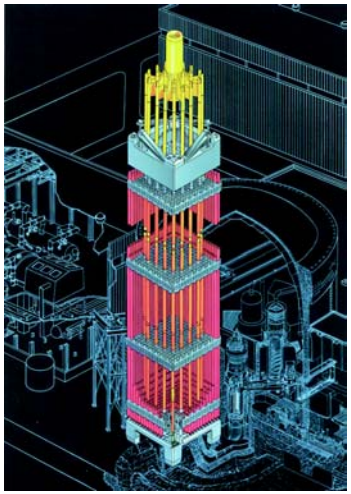
HEU is extracted from dismantled Russian nuclear weapons.

Nuclear weapons display in Russia

HEU-TIP monitor at Russian facility glove box with HEU metal being oxidized (burned)

This same HEU is converted and downblended to LEU.

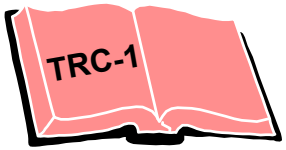
The LEU shipped to the United States is fabricated into fuel for commercial nuclear reactors.



Artist's concept of a fuel rod assembly being installed in a nuclear power reactor

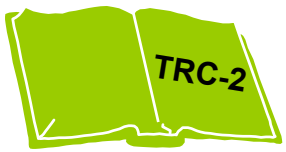
- **Transparency is designed to be evolutionary by gradually increasing levels of assurance.**
- **These measures support U.S. nonproliferation policy initiatives to permanently dispose HEU weapons material.**

Transparency Chronology

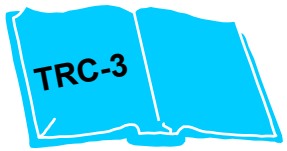


September 1994

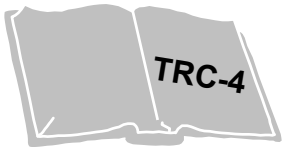
- The United States held the first HEU transparency discussions with Russia in March 1993.
- In May 1993, a U.S. delegation conducted the first visit to a Russian processing facility where HEU will be blended down into LEU.
- In June 1993, a Russian delegation conducted its first visit to the Portsmouth, Ohio Enrichment Plant and to a U.S. fuel fabricator.
- Memorandum of Understanding (MOU) related to Transparency signed in September 1993.
- Protocol to the MOU signed in March 1994. It provides additional details on transparency rights and establishes the U.S./Russian Transparency Review Committee (TRC).
- The second TRC signs Annexes 1 & 2. Each annex provides specific detail on implementing monitoring rights for each country.
- On June 23, 1995, the first shipment of LEU converted from weapons HEU arrives at the Portsmouth, Ohio enrichment plant.



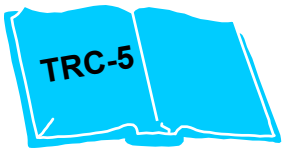
July 1995



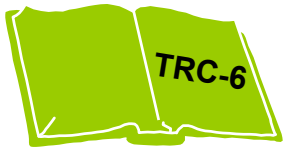
November 1995



April 1996

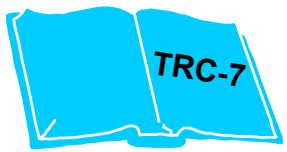


December 1996

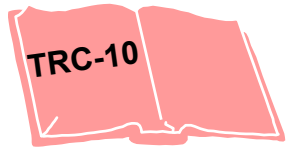


November 1997

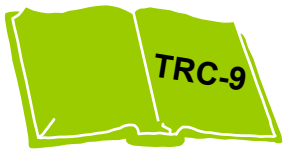
February 1998



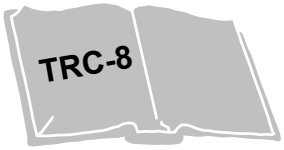
July 1999



August 2003

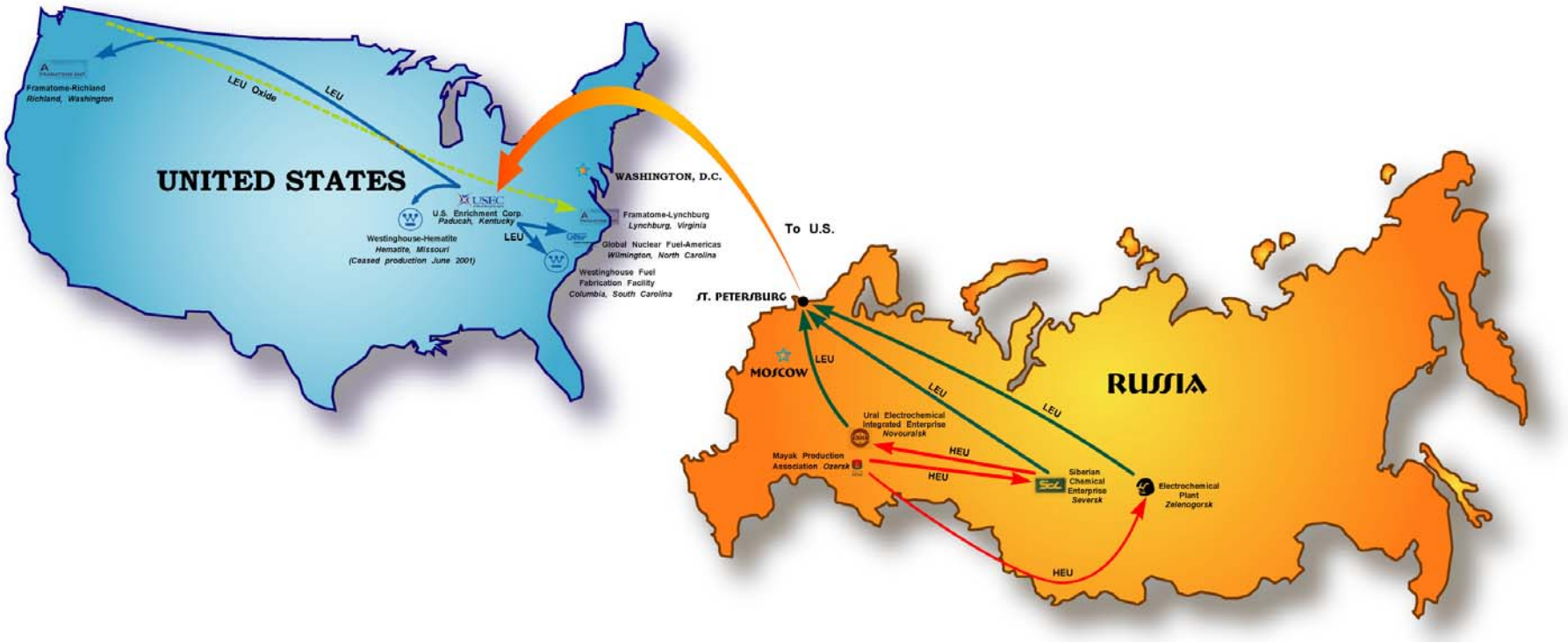


November 2002



July 2001

Facilities Subject to the Agreement



Arrows Indicate the Flow of Material
Red is HEU Gold / Blue is LEU

Russian Facilities and Processes

Two Russian facilities receive HEU weapons components from dismantled Russian nuclear weapons

Siberian Chemical Enterprise (SChE) in Seversk

HEU-TIP monitors inspect weapons components transport containers at MPA

- Receive weapons components
- Convert metal components to chips
- Convert metal chips to oxide
- Purify the oxide
- Ship purified oxide to SChE & ECP

HEU-TIP monitors inspect HEU oxide containers at SChE

Mayak Production Association (MPA) in Ozersk

Russian Facilities and Processes

Three Russian facilities convert and blend down HEU to LEU for shipment to the United States

Blend point at SChE

Siberian Chemical Enterprise

LEU cylinder filling station at ECP

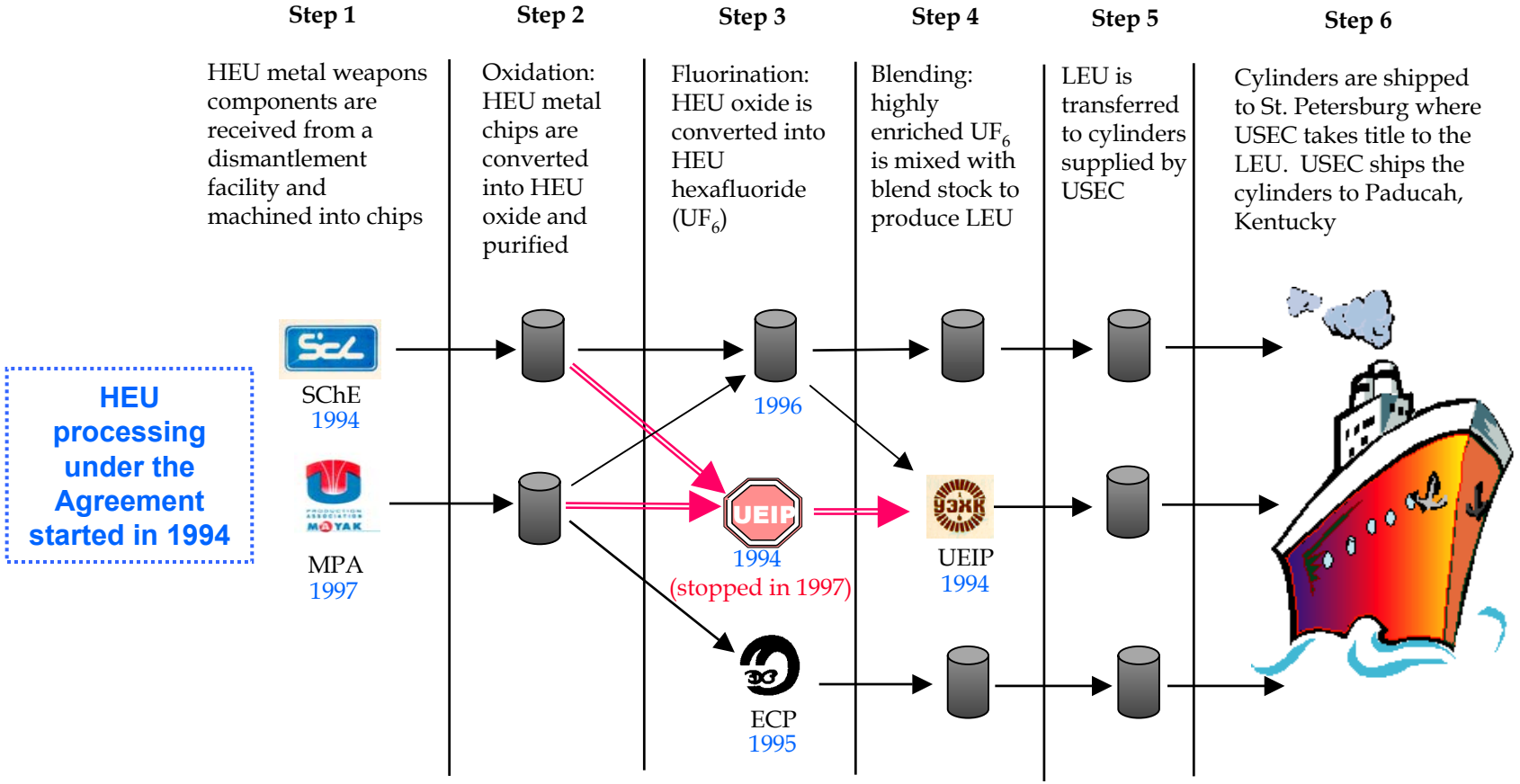
Electrochemical Plant (ECP) in Zelenogorsk

Monitors in front of BDMS Flow Monitor Instruments at UEIP

- Receive HEU oxide
- Convert oxide to UF_6
- Down blend HEU into LEU
- Ship LEU to USEC

Ural Electrochemical Integrated Plant (UEIP) in Novouralsk

Transparency Implementation: Monitoring the Conversion of HEU Weapons Components to LEU



Double lines indicate discontinued activities. Stop sign at UEIP indicates fluorination operations ceased in 1997.

USEC - United States Enrichment Corporation
MPA - Mayak Production Association, Ozersk
UEIP - Ural Electrochemical Integrated Plant, Novouralsk
ECP - Electrochemical Plant, Zelenogorsk
SChE - Siberian Chemical Enterprise, Seversk

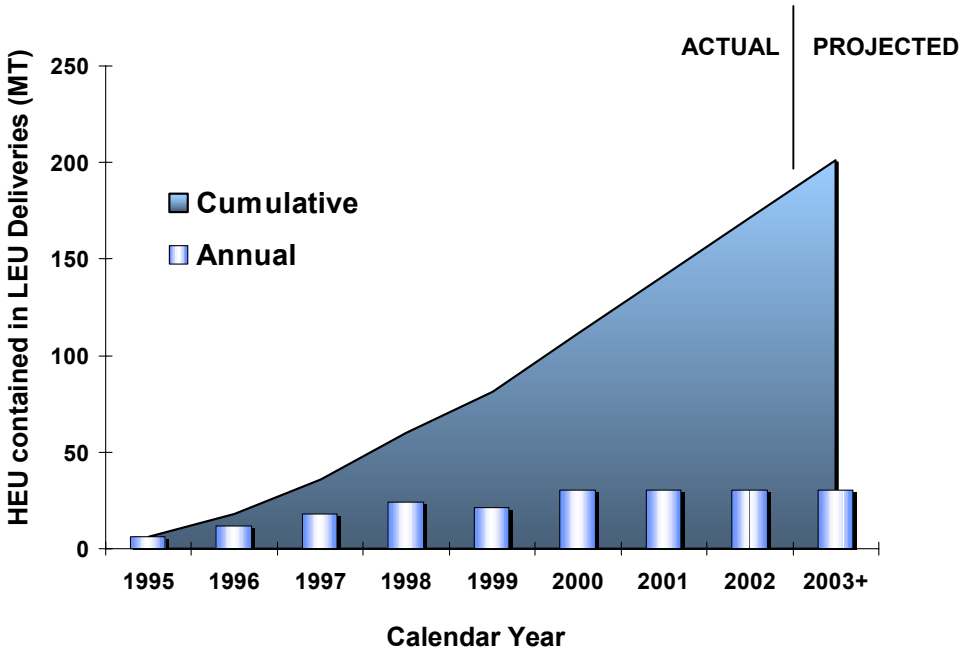
Process Facilities in the United States

- Portsmouth Gaseous Diffusion Plant received the LEU shipped from Russia (*July 1995 through February 2002*).
- Paducah Gaseous Diffusion Plant receives the LEU shipped from Russia (*starting in May 2002*).
- Last Russian Monitoring visit to the United States was in October 2000.
- Five U.S. Fuel Fabricators subject to monitoring by Russian Federation:
  - ***Global Nuclear Fuel - Americas, Wilmington, NC***
  - ***Framatome-Lynchburg, Lynchburg, VA***
  - ***Framatome-Richland, Richland, WA***
  - ***Westinghouse Fuel Fabrication Facility, Columbia, SC***
  - ***Westinghouse-Hematite, Hematite, MO (shutdown in 2001)***

Three Russian monitors (left) at Global Nuclear Fuel inspecting cylinders that contain LEU purchased from Russia

Russian monitors inspecting cylinders at Westinghouse Nuclear Fuel

Russian HEU Converted & Monitored



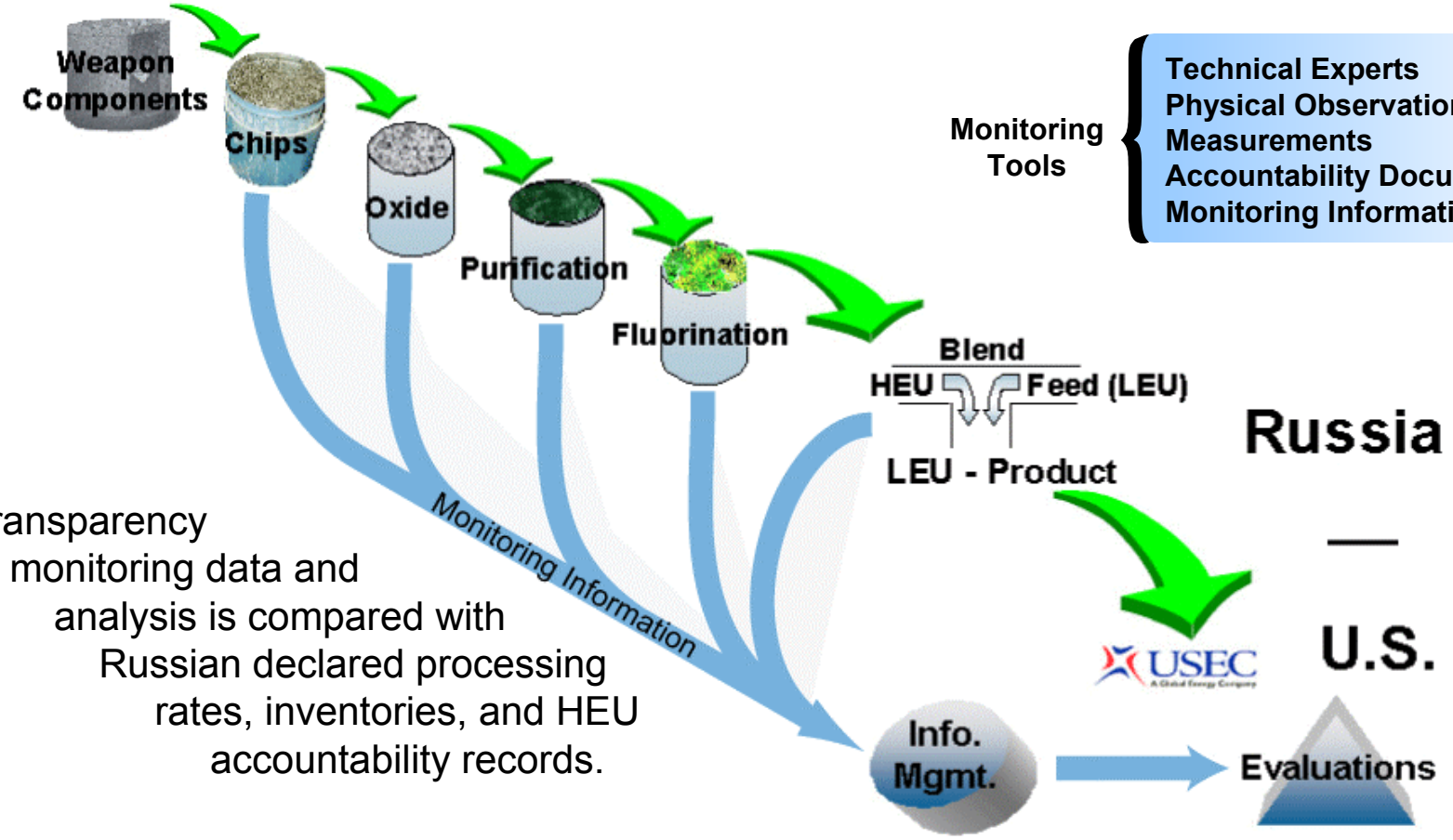
30 MT HEU Annual Projection (2000-2013)

- Through September 2003, HEU-TIP will have monitored the conversion and blending of 196.2 MT of HEU used to produce the LEU delivered to USEC.
- 196.2 MT of HEU is equivalent to 7,852 nuclear devices*.
- Russia will have delivered over 5,700 MT LEU containing over 36 million SWU and 59 thousand MT of natural uranium.
- Through the end of CY 2002, MINATOM received over $3.5 billion and over 21,000 MT of natural uranium feed was returned to Russia.
- Conversion of 500 MT HEU into 15,000 MT of LEU should be completed in 2013 under the 20-year contract.
- 500 MT of HEU is roughly equivalent to 20,000 nuclear devices*.

* Per IAEA standard for significant quantity of nuclear material

HEU Transparency Information Process

Monitors gather data on material processing rates and material containers in Russian plant storage and process areas.



Monitoring Tools

- Technical Experts
- Physical Observations
- Measurements
- Accountability Documents
- Monitoring Information

Transparency monitoring data and analysis is compared with Russian declared processing rates, inventories, and HEU accountability records.

HEU-TIP Monitoring Activities to Assure Nonproliferation Objectives are Met

Monitors annually conduct up to 24 Special Monitoring Visits to Russian uranium processing plants and staff a Transparency Monitoring Office (TMO) at UEIP to gather data on material processing rates and material containers in storage areas.

Monitors in uranium hexafluoride storage facility at SChE

Portable Non-Destructive Assay (NDA) Instrumentation is used to determine assay of HEU in Russian containers.

Monitor uses NDA equipment at Russian plant

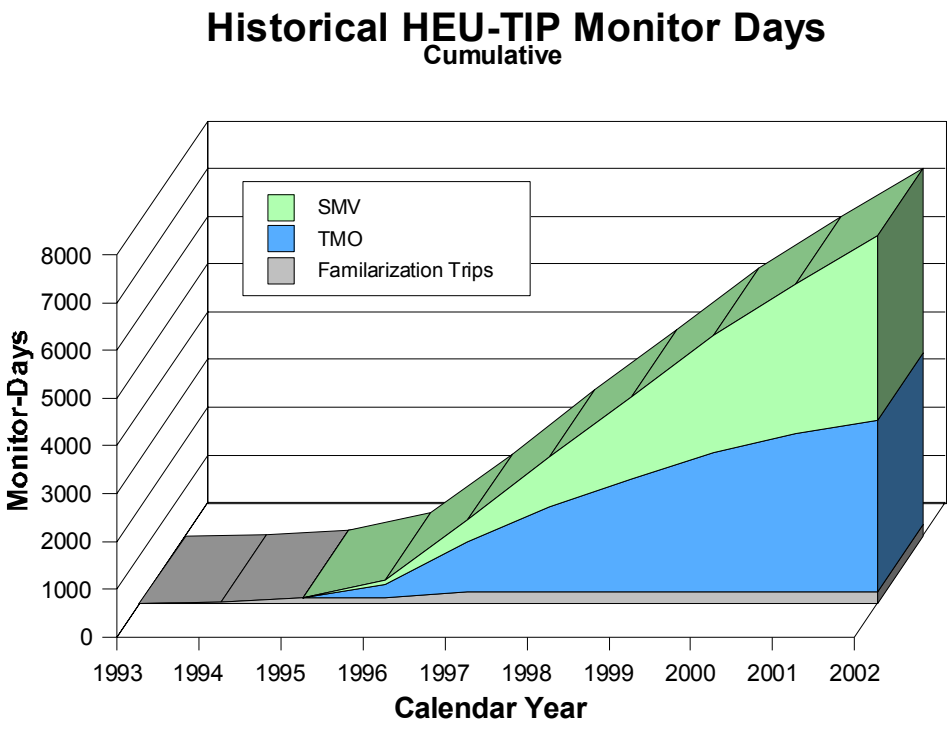
The U.S. designed Blend Down Monitoring System (BDMS) confirms the traceability, flow and enrichment assay of HEU being blended into LEU. The BDMS was installed at UEIP in January 1999.

Additional BDMS units will be installed at ECP in February 2003 and SChE in 2004.

Monitors at the Control Cabinets for the two BDMS units at UEIP

Monitoring data and analysis are compared with Russian declared rates and inventories for consistency and accuracy.

HEU-TIP Monitoring Trips



- In 2002, there were 20 Special Monitoring Visits (SMV) to four Russian processing plants and 10 monitors assigned to the Transparency Monitoring Office (TMO) at UEIP.
- From 1993 through 2002:
  - 114 TMO monitors (3,589 monitor-days)
  - 113 SMV trips (3,817 monitor-days)
  - 12 Familiarization trips
- Maximum coverage allows 24 SMV trips per year and a TMO staffed up to 12 months per year.

HEU-TIP Observations

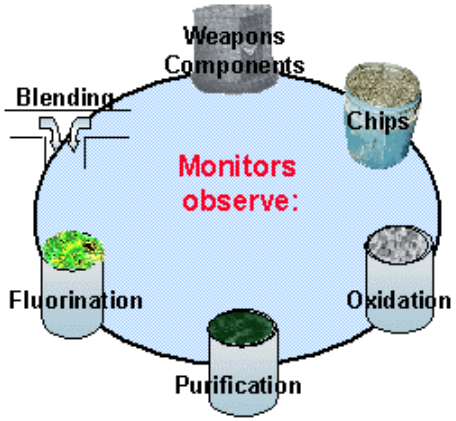
What is performed?

- Expert observation of process
- Tracking selected containers
- Compare observation and forms with process

30B cylinder (left) for LEU and cylinder overpack for transportation

What is observed?

- Process equipment used
- Process facilities and material
- Nuclear material accountability documentation



Where?

- All four facilities

HEU-TIP Non-Destructive Assay (NDA) Testing

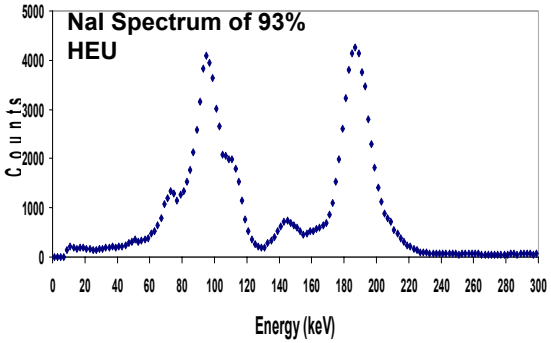
What is used?

- Portable sodium Iodide (NaI) based measurement equipment

Monitors using portable NDA testing equipment at MPA

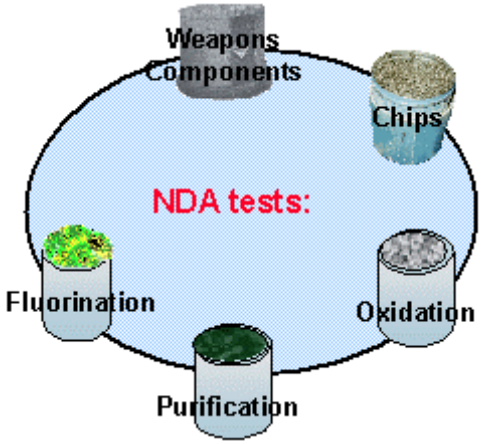
What is measured?

- Assay of HEU in closed containers



Where?

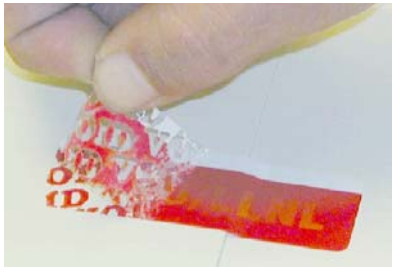
- All four facilities



HEU-TIP Tags and Seals

What is used?

Mylar/tape seal



E-cup seal

Quickseal

What is measured?

- Tamper indications for:
  - *NDA units, BDMS*
  - *Transport of HEU container (chain of custody)*
  - *Orifice plates*

Where?

- All four facilities

HEU-TIP Blend Down Monitoring System (BDMS)

What is performed?

- The system can confirm the traceability of HEU being blended into LEU.
- Confirm uranium flow and enrichment assay.
- It cannot determine HEU origin.

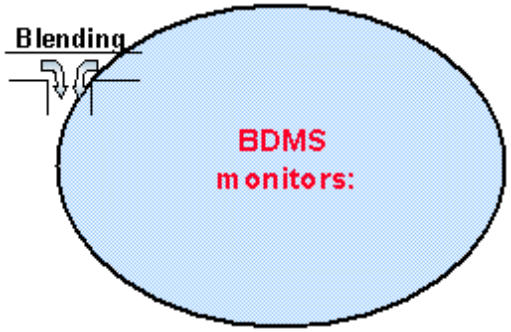
What is measured?

- Uranium assays
  - *HEU, LEU feed, & LEU product*
- Uranium flow rates
- Traceability: HEU to LEU

Where?

- UEIP - January 1999 to present
- ECP - February 2003
- SChE - 2004

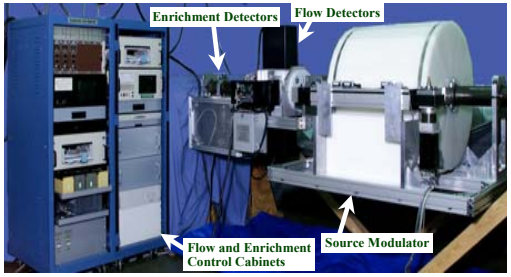
Monitors in front of BDMS flow monitor instruments at UEIP



Blend Down Monitoring System

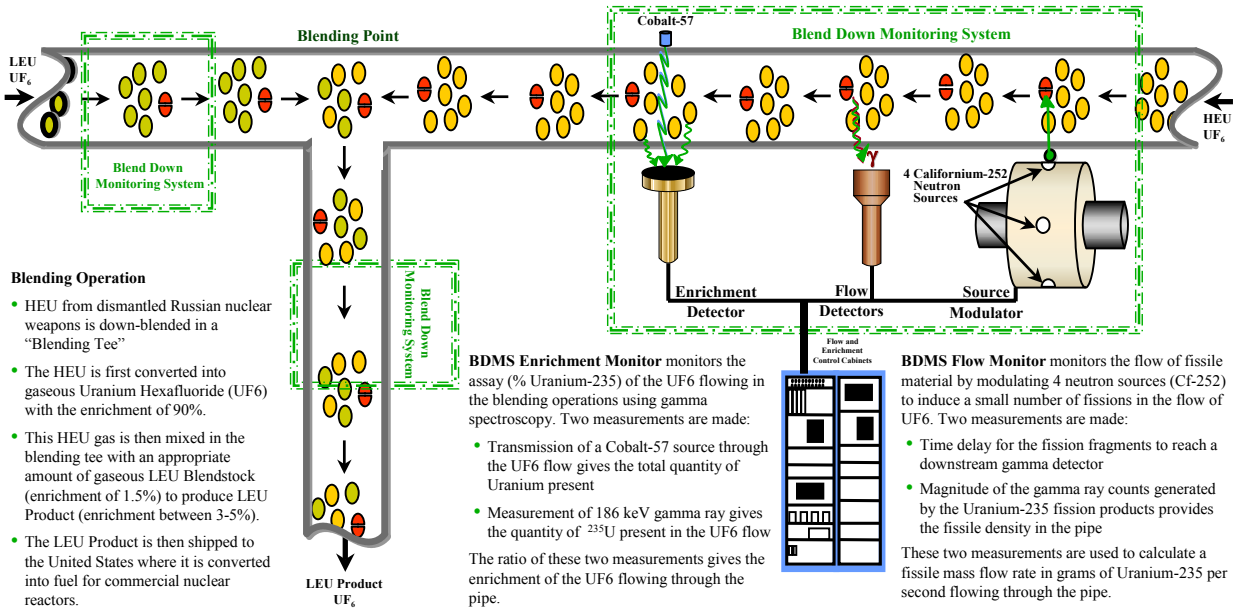
Ensuring That Nonproliferation Goals Are Met in the Blending Down of Russian Weapons-Grade Uranium

Role of the Blend Down Monitoring System (BDMS) in the HEU Transparency Implementation Program



- The BDMS significantly increases confidence that HEU is blended into LEU Product by monitoring continuously the following items through the blending operations:
  - Enrichment assays:
    - Uranium Hexafluoride (UF6) in the HEU line
    - LEU Blendstock Line
    - LEU Product Line
  - Mass flow rate of fissile material
  - Tracing the flow of HEU

Monitoring of HEU Down-Blending in Russian Facilities



Blending Operation

- HEU from dismantled Russian nuclear weapons is down-blended in a "Blending Tee"
- The HEU is first converted into gaseous Uranium Hexafluoride (UF6) with the enrichment of 90%.
- This HEU gas is then mixed in the blending tee with an appropriate amount of gaseous LEU Blendstock (enrichment of 1.5%) to produce LEU Product (enrichment between 3-5%).
- The LEU Product is then shipped to the United States where it is converted into fuel for commercial nuclear reactors.

BDMS Enrichment Monitor monitors the assay (% Uranium-235) of the UF6 flowing in the blending operations using gamma spectroscopy. Two measurements are made:

- Transmission of a Cobalt-57 source through the UF6 flow gives the total quantity of Uranium present
- Measurement of 186 keV gamma ray gives the quantity of ^{235}U present in the UF6 flow

The ratio of these two measurements gives the enrichment of the UF6 flowing through the pipe.

BDMS Flow Monitor monitors the flow of fissile material by modulating 4 neutron sources (Cf-252) to induce a small number of fissions in the flow of UF6. Two measurements are made:

- Time delay for the fission fragments to reach a downstream gamma detector
- Magnitude of the gamma ray counts generated by the Uranium-235 fission products provides the fissile density in the pipe

These two measurements are used to calculate a fissile mass flow rate in grams of Uranium-235 per second flowing through the pipe.

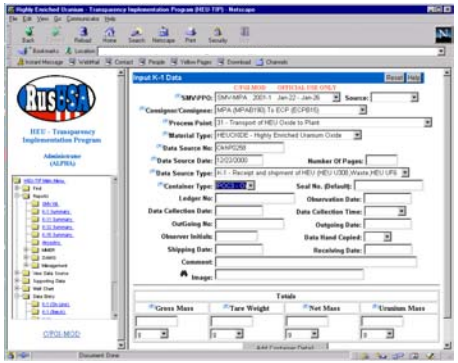
Russian Federation Delegations Received BDMS Equipment Training Twice in Oak Ridge, TN

- **Training in Oak Ridge included personnel from:**
  - ***The Ministry of the Russian Federation for Atomic Energy (Minatom)***
  - ***Russian Federal Nuclear Radiation and Safety Authority (GAN)***
  - ***Ural Electrochemical Integrated Plant (UEIP) located in Novouralsk, Russia***
  - ***Electrochemical Plant (ECP) located in Zelenogorsk, Russia***

Current Status:

- BDMS equipment was installed at UEIP in January 1999.
- The installed BDMS equipment at UEIP has significantly increased confidence that non-proliferation goals are met.
- BDMS equipment is scheduled for installation at ECP in 2003.
- BDMS equipment will be installed at the third Russian facility Siberian Chemical Enterprise (SChE) in Seversk, Russia at a future date.
- The radioactive sources for the BDMS equipment are being supplied by the Russian Federal Nuclear Center-Institute of Technical Physics (Chelyabinsk-70)

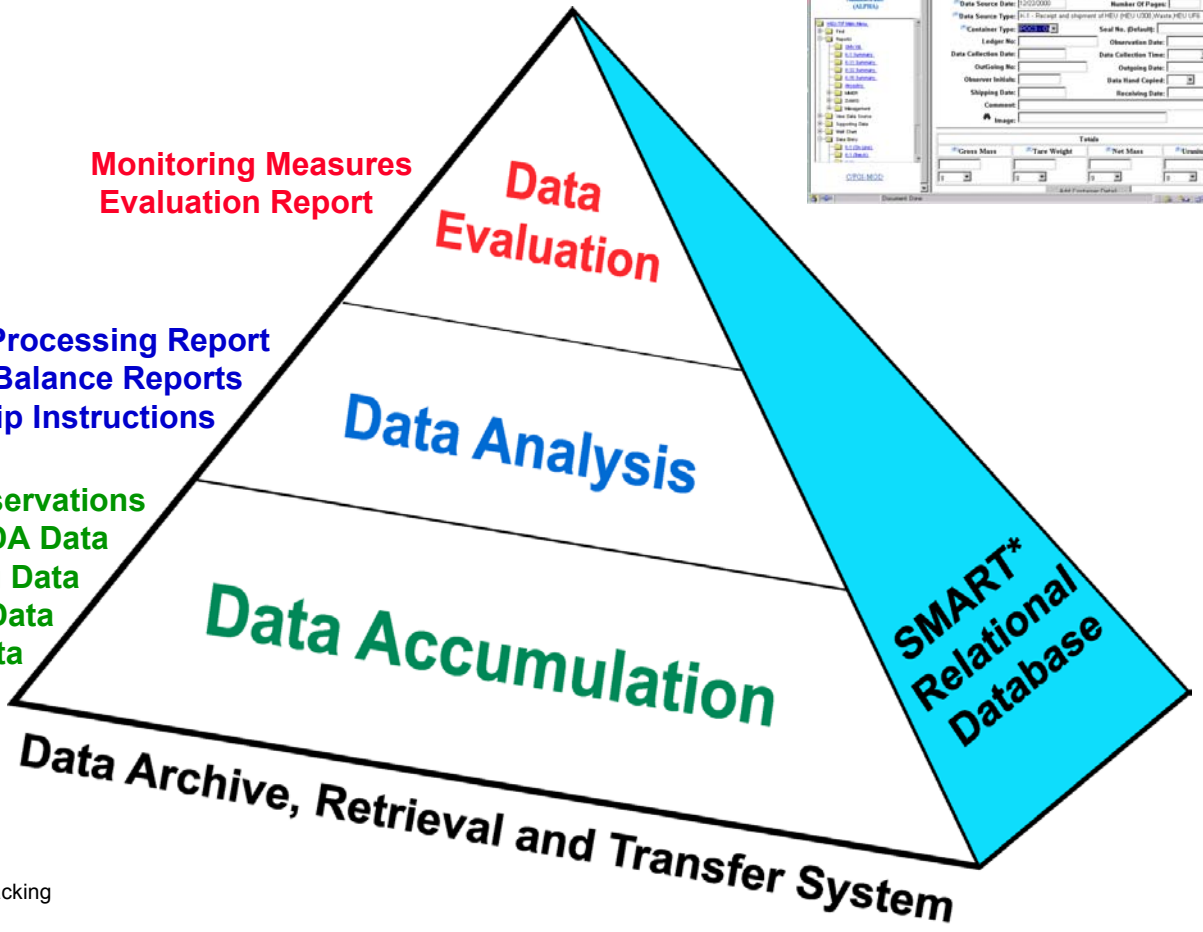
HEU-TIP
Information Management



Monitoring Measures
Evaluation Report

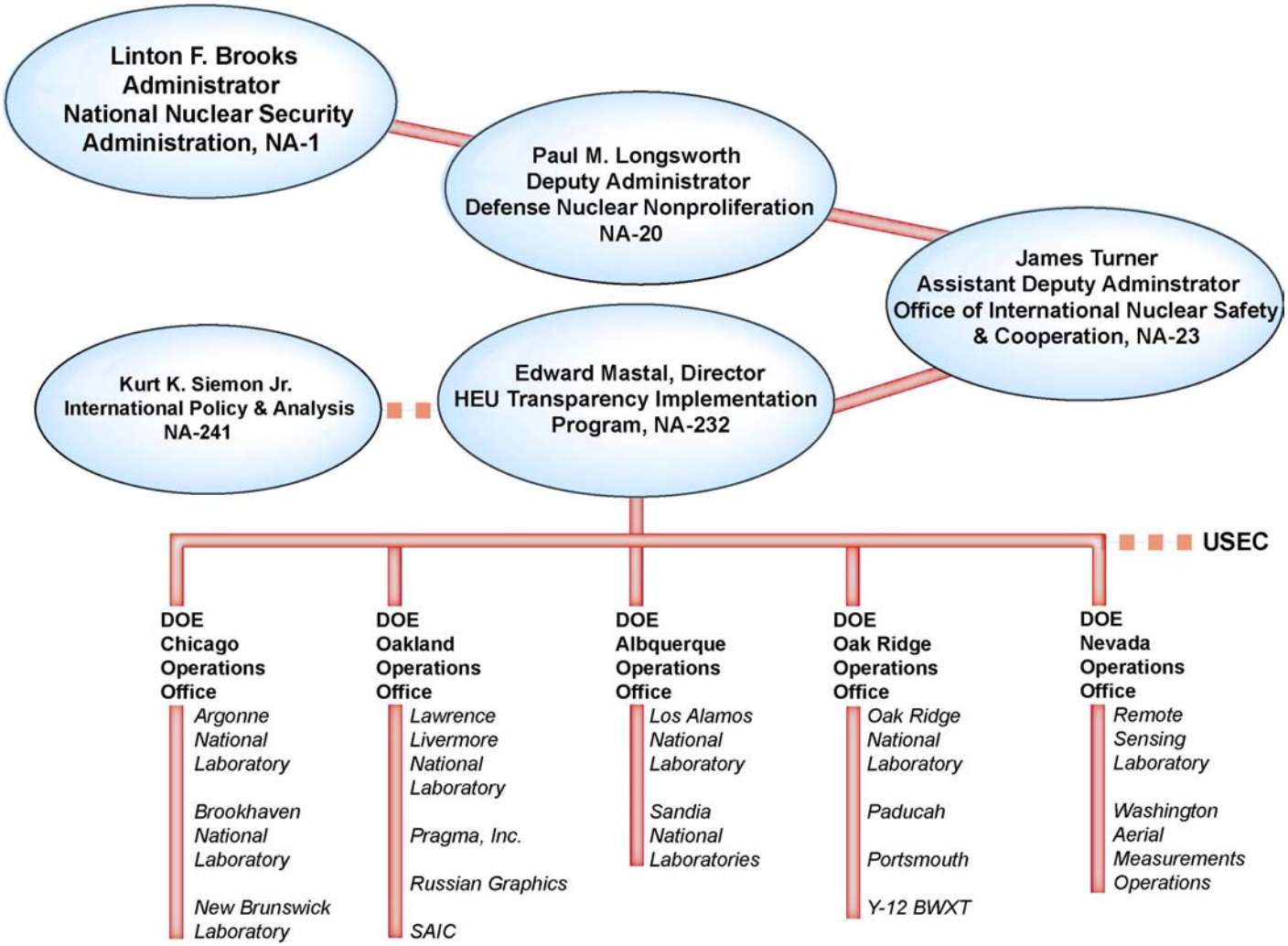
Annual Processing Report
Monthly Mass Balance Reports
Monitor Trip Instructions

Expert Observations
Portable NDA Data
BDMS Blending Data
Monitoring & Forms Data
Plant Control & Accountability Data



* System for Monitoring, Analysis, Reporting and Tracking

DOE/NNSA Organization and Coordination



HEU-TIP Strengths

"I believe that there is nothing more effective at present than this program…" Yevgeniy Adamov, Former Minister of MinAtom

- **Significant pathfinder experience with more than seven years organizing and conducting monitoring trips to four uranium processing plants in Russia.**
- **HEU-TIP coordinates its monitoring activities through an extensive infrastructure involving five DOE field offices and eight DOE laboratories located throughout the United States.**
- **Transparency Review Committee, established in 1994, negotiates monitoring rights between Russia and the United States on a continuing basis.**
- **Greater influence with MinAtom due to $12 billion, 20-year USEC contract.**
- **An established relationship with MinAtom and uranium processing plant personnel.**
- **Strong monitoring expertise with a pool of 150+ monitors.**
- **Specialized monitoring technology being used and improved.**
- **Extensive computerized data archive, retrieval and transfer system with relational database.**
- **Inter- and Intra-agency coordination.**

HEU-TIP Coordination with other Programs

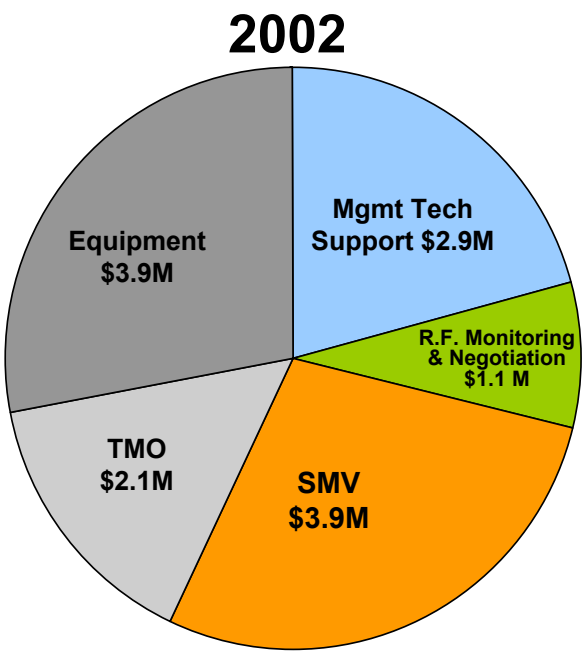
- **Information Sharing with Other Organizations:**
  - Material Protection, Control, and Accounting
  - Comprehensive Threat Reduction Program
  - Mayak Fissile Material Storage Facility
  - Fissile Material Disposition Program (U.S. HEU & Pu/Russian Pu)

- **Support includes:**
  - Working group to facilitate problem solving and technical integration
  - Russian facility information exchange / coordination
  - Coordinating work efforts during site visits
  - Sharing HEU-TIP work products
    - Health and Safety Plan
    - Russian Facility Data
    - Experience
    - Expertise

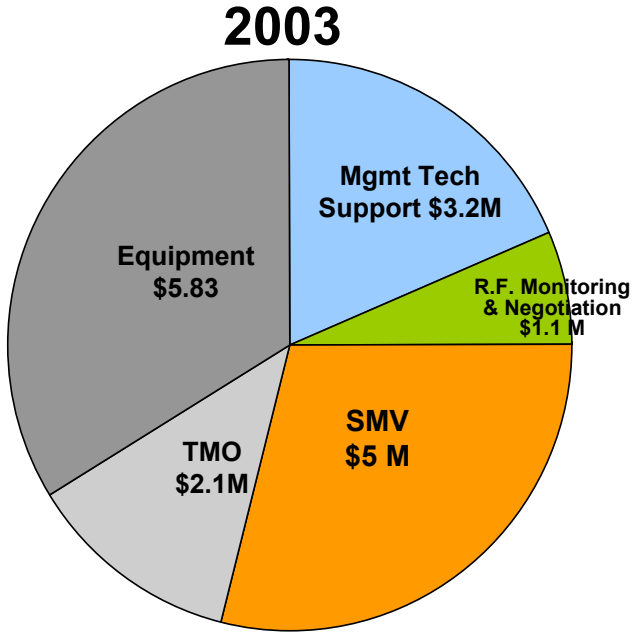
HEU-TIP Accomplishments
for Calendar Year 2002

- Conducted over 100 SMV trips since 1996 to four Russian uranium processing plants.
- Conducted 20 SMV trips and monitored the four Russian plants for 194 monitor-weeks.
- Preformed about 3,000 measurements using portable NDA equipment to confirm ^{235}U enrichment in Russian HEU containers and cylinders.
- Observed more than 20 percent of all HEU containers declared by Russia to contain HEU weapon components, chips, purified oxide, and uranium hexafluoride (UF_6).
- Monitored with the BDMS all the HEU down blended at UEIP. BDMS availability during the year was 90%.
- Observed 62 percent of the HEU received at UEIP, or about 33 percent of all HEU processed at UEIP.
- Celebrated the TMO's sixth anniversary at the Ural Electrochemical Integrated Plant (UEIP) in Novouralsk. TMO monitors have completed over 100 TMO assignments since 1996.
- Completed preparations to install a BDMS at the Electrochemical Plant (ECP) in Zelenogorsk. The signing of the revised Annex 15 allowed for the planned installation to be scheduled in February 2003.
- Completed the second inventory verification of natural uranium feed component returned to Russia during 2001.
- Operated a secure database and communications system between 14 U.S. sites to centralize and manage monitoring activities and data.
- Received, archived and processed over 7,000 pages of Russian facility material control and accountability (MC&A) records.
- HEU-TIP monitors provided voluntary humanitarian assistance in Russian communities.

HEU-TIP
Fiscal Year Appropriations



$13.9 Million



$17.23 Million

HEU-TIP Humanitarian Efforts in Russia make a Difference

Volunteering

Volunteers wrapping Christmas gifts

Sofia and her mom

Sharing

Giving gifts at an orphanage in Seversk

School classroom in Mayak (MPA)

Children at the orphanage at Seversk (SChE)

Caring

Sergei with his parents and Monitor
(Sergei and Sofia underwent successful heart surgery with assistance from HEU-TIP personnel)

Children putting on a show at an orphanage in Zelenogorsk (ECP)

Making a Difference

Monitors accepting gift in Zelenogorsk

Since 1999 many of the men and women that travel to Russia for the HEU Transparency Implementation Program have shared their free time with local children from orphanages and schools within the Nuclear Cities where the Russian facilities are located. In addition to giving clothing, shoes, candy, and toys, the children have also received cards, books and personal care products. Monitors have also reached out to assist in finding free medical assistance for some of the more seriously ill children in these cities. Although NNSA is not chartered to fund humanitarian efforts, all charitable work is performed by monitors on their own time whether in the United States or on travel in Russia.

For further information contact:
Edward F. Mastal, Director
HEU Transparency Implementation Program
National Nuclear Security Administration
NA-232 / Germantown Building
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1290
Telephone: 301-903-3197
Email: edward.mastal@nnsa.doe.gov